Deciphering stellar activity with K2 photometry and ground-based radial velocities

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Stellar intrinsic variability poses one of the main challenges to the discovery of the smallest terrestrial planets and the measurement of their atmospheres. Variability is often caused by magnetic activity and, as such, it has an apparently stochastic nature. This is why the impact of activity on photometry or radial velocities is often referred to as □jitter□ and treated as a noise source. But this approach is just a consequence of our lack of knowledge of how stellar magnetic activity works. If understood in sufficient detail, one could turn the supposed □noise□ into □signal□ and therefore correct it out. A particularly interesting possibility is to use simultaneous photometry and precision radial velocities to break some of the degeneracy and better constrain the reconstruction of the stellar surface, as well as studying parameter correlations. This was put to practice for the active planet host star HD 189733 with relatively good success but also highlighting the need to expand the test to other stars with extended time baselines and coverage density. K2 long-cadence photometry, in simultaneous combination with radial velocities from the ground, offers a unique opportunity to contribute critical information to the better modelling of stellar activity and subsequent correction of precise photometry and RVs for exoplanet discovery and measurement.

Our strategy comprises the selection of stars with moderate activity level in the K2 fields. Field 4 is particularly interesting since it covers part of the Hyades cluster, whose GK member stars are relatively bright and have the appropriate activity levels. Using several criteria we have selected V=7.5-8.5 mag G-type stars with log R□HK around -4.5 in Field 4 and Field 5. The precise photometry from K2 will be complemented with ground-based RVs from the HARPS-N, TRES, and SOPHIE instruments to which the proposers have direct access and deliver measurements with precisions better than a few m/s. This will allow us to obtain simultaneous RV measurements for the targets, at a rate of one measurement per night, and for a time baseline of about 40-50 days. This represents several rotation cycles of the targets as they are expected to rotate with periods of ~10 days. The combination of K2 data and ground-based RV measurements is key to further our understanding of stellar activity and to turning a □noise□ component into correctable □signal□, thus opening the way for the discovery of smaller exoplanets (using both photometry and spectroscopy) and for the eventual measurement of the minute signature of their atmospheres. Combining precise ground-based spectroscopy and space-based photometry of bright stars will be commonplace in the near future with the TESS mission. This proposal therefore represents a case study for such upcoming investigations.